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DISCUSSION OF AERONAUTICAL CHARTING AND MAPPING PROCEEDINGS-SEPARATE NO. 172

E. S. Fabian,[2] A.M. ASCE.—An excellent presentation of the development

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of aeronautical charting and mapping has been prepared by Comdr. Schanck. The author has stated clearly the many problems involved in preparing the several kinds of aeronautical charts and maps which will best satisfy specific aeronautical needs.

The most obvious need for the aeronautical chart is in connection with aerial navigation. Aerial navigation is a complex operation requiring specialized training, specialized navigational instrumentation and aids, and the high degree of skill that is developed with experience. In general, the problem of aerial navigation consists of three parts: First, the preparation of the flight plan or "laying out" the course of flight from the point of departure to the point of destination; second, the establishment of a sequence of check points along the course of flight by which the navigator can check the aircraft's progress while in the air; and third, the actual execution of the flight plan with the full and correct knowledge at any time of the exact position of the aircraft along the flight course.

The importance of an accurate aeronautical chart in the solution of the first two parts of navigational problems is quite obvious. The chart must correctly represent the geographic relations of both distance and direction of the landing fields and it must show the geographic location of the most prominent topographic features which will serve as recognizable "check points." These points must be shown for the entire area represented by the map. Either through errors of navigation or the action of the elements, aircraft frequently stray from the planned line of flight and become "lost." The navigator must then be able to establish the aircraft's position by reference to recognizable features on the ground which are represented on the chart, so that the aircraft can be promptly returned to the planned route or to an alternate route.

If the flight is to be executed on instruments the topographic features shown on the map will be of little navigational value. The features will be obscured by the weather or darkness or they will be unrecognizable at a high altitude. Instrument flight must be guided by radio navigational aids such as radio ranges, radio beacons, and the various types of markers. If the aeronautical chart is to serve as a guide for instrument navigation, it must show the correct geographic location of these aids and unmistakably identify each.

When only the first two parts of the problem of aerial navigation are considered, namely the preparation of a flight plan and of the flight control, the cartographer's problem appears to be relatively simple—not much more difficult than that of producing a good geographic map. It is only when the third part of the problem of aerial navigation is considered—the execution of the flight plan by use of the aeronautical chart—that "the psychology of space orientation" occurs. The aerial navigator must be oriented at all times; he must know the exact position of his craft within some familiar framework. Complete orientation without any maps or charts is possible over only a very limited territory with which the navigator is completely familiar. In any other case the framework of orientation is the aeronautical chart on which the aircraft is represented as a point to be correctly located at any moment, with reference to the symbols shown on the chart. The orientation consists in

establishing correctly the correspondence between the signals received from the earth below, whether the signals be photographic images or radio signals. To establish this correspondence the aeronautical chart must be an exact image of only those features on the surface of the earth which can be unmistakably translated (by the navigator) from a signal to a symbol.

Selection of the most recognizable land features and adoption of chart symbols that will permit the easiest and most reliable translation from signal to symbol are the cartographer's most difficult problems. Enough features of visible landscape must be shown to permit a complete coverage of the area shown on the chart. If too many features are shown, they will confuse the navigator; if too few are shown, the navigator lacks possible means of orientation. The powers of observation and comprehension vary among navigators. A good chart will not show all geographic and topographic details, but only those features which trained observation will grasp quickly and trained comprehension will identify unmistakably. The selection of the features to be shown on the chart must be made from the navigator's point of view and with reference to the mental process involved in space orientation. The teacher of navigation, the navigator, and the cartographer must cooperate to produce a good aeronautical map.

The selection of symbols by which the recognizable features are to be represented on the chart in their proper relations is a difficult problem. Some features, such as roads and their intersections, railroads, and rivers are best symbolized by their likenesses. Others, such as swamps, lakes, and large bodies of water are best represented by outline, shading, and color; and still other features, such as cities, towns, bridges, industrial areas, and navigational aids, by suggestive symbols or brief descriptions. The adopted symbols must permit the easiest identification from the signal received so that the correspondence of the ground below can be quickly and correctly established to the part of the chart which it represents.

Cartographers have ably solved these problems in producing navigational maps and charts. The charts are accurate and their general composition permits quick training in observation for comprehension and the development of the power of space orientation. The present methods of aerial navigation, whether in accordance with contact flight rules or instrument flight rules, are well served by existing navigational charts.

These charts can be improved, if they are regarded as representing only a stage in the long process of cartographic evolution. The fact remains that aircraft get lost, sometimes with disastrous results. How many and what proportion of navigational errors are chargeable to human frailty and the failure of navigational instrumentation and how many and what proportion to the shortcomings of the charts must be determined by careful studies. Aviation psychologists might be able to indicate the direction of chart improvements as has been done in the fields of pilot training and selection, in instrumentation, and in other fields. Improvements in technical factors of aeronautical charting can also be expected, because, as Comdr. Schanck indicates, cartography is not a static science.

The charts are adequate for the usual methods of aerial navigation. However, there are increased navigational requirements for both the improved aircraft and navigational aids. Universal adoption of the omnidirectional range as a navigation aid will render the existing charts inadequate. A

successful development of ground and airborne radar as instruments for navigation and air traffic control might render these navigational charts obsolete. The basic problem, however, will remain the same for the science of cartography; it must still provide a framework for orientation in space on which the correspondence between the signal and the symbol must be established by the aerial navigator. Experience indicates that there may be expected of the science of cartography production of charts and maps as adequate as those which are used for the existing methods of aerial navigation. It is probable that these charts will be superior, in view of the expected improvements in the art of map making.

The reliability of the aeronautical charts—their accurate and full representation of all features necessary for the solution of navigational problems—deserves special comment. There are continuous changes in the condition of the airports. New landing fields are being built and new landing facilities are being added. Airways are frequently relocated and new ground navigational aids are commissioned. There are also frequent changes in the landscape resulting from the building of new highways and relocation of the old ones. The contours of lakes and rivers are frequently changed by the building of dams. New industrial areas are constantly being developed. All these changes on the surface of the earth render navigational charts inaccurate from one issue to the next. Just what are the criteria for determining the obsolescence of the charts and what are the factors which determine the necessity of a new issue? The normal procedure of supplementing the navigational charts and maps and indicating the pertinent changes is use of a bi-weekly volume issued by the Office of Aviation Development of the CAA. In addition to the changes in flight rules, this volume contains corrections, changes, and additions to the aeronautical maps and charts. This information is compiled from reports of the CAA district airport offices, from airway communication centers, and from CAA regional offices. Thus the navigational information is made accurate every two weeks. More urgent information is transmitted to the flight control centers by use of teletype and immediately urgent information is broadcast directly to the aircraft by use of radio communication. Much of this information is only of temporary importance, but some of it represents permanent departure from the information shown on the charts in use, and necessitates their revision.

The large distribution of aeronautical charts indicates that the charts must be used by others besides aircraft personnel; federal, state, and private aviation planning agencies make use of the various types of charts in planning regional aviation development. While directing aviation development in Tennessee, the writer has used sectional charts as base maps for planning a development of secondary airways, in locating intermediate and secondary airports, and in preparing an air marking plan. The various charts were also used in making aviation facility inventories and in planning the development of additional facilities. Cooperation with the CAA, in carrying out the National Airport Plan required continuous reference to aeronautical charts of various types.

Airports managers, planners, and engineers make excellent use of airport, radio facility, and airport obstruction plans. Comdr. Schanck mentions specifically the use of airport obstruction plans in connection with zoning studies and in the planning of new airport construction. When used in connection with topographic and aerial survey maps, the aeronautical charts permit pre-

liminary location and engineering studies for airports. The charts also minimize the number of field surveys necessary for preparing construction plans.

Aeronautical charts and maps are necessary aids and references in traffic control, in planning and controlling aircraft operations in airline offices, in aircraft accident investigations, and in the many other activities of the CAA and the Civil Aeronautics Board. The very characteristics of these charts which make them useful for air navigation are responsible for their usefulness on the ground. The charts are probably used in greater volume in connection with ground aeronautical activities than for aerial navigation.

The usefulness of the charts as teaching aids and instruments for classroom practice must not be overlooked. Flight schools, aeronautical ground schools, traffic control training centers, airline training schools, and engineering schools find the charts not only useful but necessary in the training of students. It is this widespread usefulness and excellence of aeronautical charts and maps which account for their annual multi-million distribution. The volume of distribution may well be an index to the growth of aviation.

PHIL M. MILES.[3]—The history of the development of aeronautical charts

[3] Chf., Maps and Minerals Div., Agri. and Industrial Development Board, Kentucky.

and their use in the United States has been presented by Comdr. Schanck. An examination of the production and use of these charts, both in the United States and other countries, leads to the conclusion that their quality is unsurpassed.

It is vital to the development of aviation that a complete series of aeronautical charts, from relatively large-scale instrument-approach and landing charts to small-scale charts required for navigation of high-speed aircraft, be produced and maintained. The cost of production and development of a complete series of charts is an infinitesimal part of the cost of conducting the aviation industry.

The USCGS and other agencies and groups are constantly endeavoring to develop more useful cartographic designs for aeronautical charts. These charts will enable all pilots, and especially the inexperienced pilot, to make better use of such material. A more complete and easily interpretable presentation of relief and prominent landmark objects is the objective of cartographic development. For example, current (1953) aeronautical charts show relief by a color-gradient tint that represents intervals of 1,000 ft or 2,000 ft, contours at 500-ft intervals. This leaves much to be desired in illustrating the roughness of the terrain and this is most important in selecting flight routes for light aircraft. In the event of power failure or adverse weather conditions, the availability of suitable emergency-landing areas is of utmost importance to the light-aircraft operator.

Notable development work is being conducted (1953) at Ohio State University, at Columbus, under the direction of George Harding, A.M. ASCE. This cartographic unit is experimenting effectively with various methods of relief presentation on maps and charts. Some of these methods show promise. Noteworthy also are the accomplishments of the USCGS in supplying excellent aeronautical charts, despite inadequate topographic coverage in the United States.

The expansion of large-scale topographic operations following World War II, especially in the eastern and middle-western areas of the United States, will enable the USCGS to correct many errors that were beyond its control in earlier charts. Unfortunately, few users of aeronautical charts appreciate either the efforts of the USCGS cartographers to show accurately the information required, or the efforts continually made to improve the charts.

CHARLES A. SCHANCK,[4] M. ASCE.—The comments of Messrs. Fabian and Miles are valuable contributions to the subject of aeronautical charting and mapping. Exception can be taken to Mr. Fabian's statement that aeronautical charts are probably used more frequently in connection with ground activities than for aerial navigation. It is unlikely that accurate figures are available on the number of aeronautical charts used in various fields of the aviation industry. Certainly, however, many charts are used which are never carried in an airplane.

[4] Comdr., U. S. Coast and Geodetic Survey, Washington, D. C.; formerly Asst. Chf., Div. of Charts.

It is regrettable that everyone is not as aware as Mr. Fabian of the usefulness of these charts as training aids. As he writes, "aircraft get lost." Perhaps fewer of them would get lost if pilots were thoroughly instructed in map reading during their pre-flight training.

Mr. Miles' statement that much is still to be desired in illustrating the roughness of terrain cannot be refuted. Every governmental agency engaged in charting or mapping constantly strives to find a remedy for this unsatisfactory condition. These efforts are well coordinated. The agencies also follow closely the developmental work being conducted at Ohio State University and other research centers. It is this compilation, by all interested groups, of cartographic knowledge that will produce better aeronautical charts.

DISCUSSION OF ELECTRONIC DEVICES IN AIR TRANSPORT PROCEEDINGS-SEPARATE NO. 173

P. C. SANDRETTO.[3]—World War II ended in 1945, and in 1946 the population of the United States began to think seriously of peaceful living. The airlines had been operating with every aircraft filled to capacity with passengers and cargo. A large percentage of airline passengers were military personnel until 1946, when the public began to fly the airlines and found that the airlines continued to have not only accidents but also long periods of waiting as the aircraft circled the major air terminals. Immediately, there were protests from all persons concerned. Three magazines carried articles concerning navigational facilities.[4,5,6] The House of Representatives, United States Congress, held hearings to investigate what was wrong with air-transportation aids and air-navigation aids, and the report of that investigation committee was published in July, 1947.[7]

[3] Brig. Gen., USAFR, Asst. Technical Director, Federal Telecommunication Labs., Inc., Nutley, N. J.

[4] "What's Wrong With the Airlines?", *Fortune*, August, 1946.
[5] "Is the Air Full?" *Harper's*, July, 1946.
[6] "For Landings Sake," *Collier's*, January 3, 1948.

[7] "Safety in Air Navigation," by John H. Frederick, Committee on Interstate and Foreign Commerce, House of Representatives, U. S. Cong., Washington, D. C., July 24, 1947, p. 21.

Many of the articles and investigations criticized the proposed CAA navigation program. The CAA had begun, in 1936, the development of very-high frequency navigation facilities and instrument low-approach systems. On its small budget it had worked diligently through the years to produce better aids to replace those which had been designed in 1927. The CAA was prepared to install new aids when World War II began., There had been approximately six fixed-beam approach systems installed in various major terminals in the United States, and a line of very-high frequency radio ranges was operating between Salt Lake City, Utah, and Los Angeles. During World War II the CAA did not have access to the classified systems used by the military. The CAA did, however, continue to improve the very-high frequency range and the fixed-beam approach systems. When the end of the war came the CAA program had been formulated. Many of the accusations made at that time were that the CAA's program was not "modern" because it did not include radar devices. The CAA engineers may not have been well acquainted with the radar developments, but, similarly, many radar designers were equally unfamiliar with civil aviation, its high standards of safety, and low cost, which are necessary in civil air operations.

The confused reports reaching the federal government impeded progress on the implementation of an air-navigational aid program in 1946 and 1947. Credit should go to Delos W. Rentzel for convincing the federal government that the RTCA-SC-31 should be given the opportunity to resolve these differences of opinion. The RTCA-SC-31 did its work in two phases—the first phase (completed in twelve meetings and under the chairmanship of Col. J. B. Duckworth, United States Air Force) determined the operational requirements. The second phase (under the chairmanship of Capt. A. S. Born, United States Navy, meeting almost continuously from October, 1947, to February, 1948) took the operational requirements of phase one and established the programs referred to as the "common system."

The RTCA-SC-31 began work by examining the aids that had been developed by the CAA. The committee did not find that the developments made by the CAA should be discarded but, on the contrary, concluded that these equipments

formed the backbone of the only system which was ready to be installed. Through the many newly-proposed systems presented before the committee, it was evident that the CAA devices did not constitute the optimum design which could be produced by utilizing the best of the war-developed techniques. However, it was equally evident that they constituted completely workable, useable, and practical equipments which would go a long way toward improving air operations in the United States. The committee next investigated what improvement to the system would result by adding some of the World War II-developed devices. These devices were GCA (ground control approach)-radar low-approach system, surveillance radar, very-high frequency direction finders, responder beacons, and distance measuring equipment. Distance measurement, by the use of pulse techniques had become common during the war, but the equipment the RTCA-SC-31 specified was to be a new development. After outlining a system based on the group of equipment described by Mr. Lee (eventually known as the "interim program"), it was found to have a factor of merit of 67%. This rating is recorded in the final report.

In spite of many weeks of debate, unanimous agreement on the installation of the interim system was impossible, so the committee spent a number of months developing the ultimate system. The ultimate system offered a co-ordinated program and, among other features, specified air-borne navigational equipment[8] which would weigh 20 lb, have an azimuth accuracy of $\frac{1}{2}°$, have a

[8] "Air Traffic Control," Special Committee 31, Radio Technical Commission for Aeronautics, Washington, D. C., May 12, 1948, pp. 55-58.

distance accuracy of 0.2 mile, and provide for instrument landings and other services. With promises that the ultimate system could be realized within fifteen years, the recalcitrant members of the RTCA-SC-31 agreed to the interim program and the final report was issued.

Since this RTCA-SC-31 meeting, the CAA has pursued the interim program. This group is to be commended for the manner in which it has attempted to carry out the recommendations of the RTCA-SC-31 which have, in fact, no official standing. The RTCA-SC-31 report stopped all criticism and brought together the various persons interested in aeronautical navigational aids. But what of the "ultimate" program?

It is felt that Americans do things rapidly, but the history of air navigation does not bear this out. Aircraft are still flying the four-course radio range that was first applied to the airways in 1927. The instrument landing system[9]

[9] "A Radio Beacon and Receiving System for Blind Landing of Aircraft," *Proceedings*, Inst. of Radio Engrs., Vol. 19, April, 1931.

devised by H. Diamond and S. W. Dunmore (1928) was first used in Europe in modified form. World War II interrupted the work, and the United States commercial carriers did not make operational-instrument very-low approaches until 1947—twenty years after their original development. Navigational programs cannot be executed on the spur of the moment, but require years of solid effort.

Mr. Lee outlined the economic questions involved in the installation of further radio aids, therein suggesting that the interim system must be used beyond the fifteen-year period which the RTCA-SC-31 envisioned. The interim program is satisfactory for today's (1953) needs, but will confusion once again force remedial action? The RTCA-SC-31 attempted to exercise foresight by planning a program fifteen years in advance, known as the ultimate system which "sold" the common system to the operating air agencies of the United States. If there is delay in effecting the program for the ultimate system, it can be envisioned that the "air that is full" again places limitations on air operations and national security.

F. B. LEE[10].—The excellent discussion by General Sandretto shows a keen

[10] Administrator of Civ. Aeronautics, Civ. Aeronautics Administration, Washington, D. C.

insight into the major problems facing the federal government in providing air navigation and traffic control facilities and services. There must be continuous research, development, and planning to enable the air navigation and traffic control services to keep ahead of the requirements of the aviation industry. General Sandretto summarized the problem succinctly when he asserted that "* * * navigational programs cannot be executed on the spur of the moment, but require years of solid effort."

It is the intent of the CAA, and all those working with navigational systems, to meet the ultimate requirements of the users of the common system of air navigation and to maintain the high standards of safety and low cost essential to the development of aviation.

DISCUSSION OF ZONING MAPS FOR AIRPORTS
PROCEEDINGS-SEPARATE NO. 174

HAROLD M. LEWIS,[2] M. ASCE.—The CAA requirements for clearances on airport approaches have been clearly presented by the author. There is an obvious need for protecting these approaches through the use of zoning ordinances. The Zoning Commission of New Castle County, Delaware, has attempted to do this in a zoning code[3] prepared under the direction of the writer. The code supplies an interesting example of the way in which Mr. Beavin's objectives have been adapted to a specific case.

[2] Cons. Engr. and City Planner, New York, N. Y.

[3] "Proposed Zoning Code of New Castle County, Delaware, Revision of March 3, 1953," prepared for the New Castle County Zoning Comm. by Harold M. Lewis, New York, N. Y. (Mimeographed.)

Airport zoning by use of the usual municipal ordinances is handicapped by the fact that the runway approaches (which should be protected) generally extend far beyond the limits of the municipality. This was not the case in New Castle County, where there is now (1953) only one major airport—the New Castle County Airport—situated about 5½ miles southwest of the center of the city of Wilmington, Del. The airport is located near the western approach of the Delaware Memorial Bridge and it is within an area that experienced very rapid development in the period following World War II. Classified as Class 1 by the CAA, the airport is used as a training center for jet airplanes by the Air Force. The airport management, the pilots, the county officials, the local population, and the real estate interests all recognize the need for some control for the sake of safety and orderly development.

The proposed zoning code for New Castle County will apply to all the unincorporated areas of the county. These areas represent 95% of the total county area of 433 sq miles, with a population in 1950 of 80,413 (approximately 37% of the total county population). The municipality nearest the airport is New Castle, the center of which is 1½ miles from the eastern edge of the airport. Newark, Del., an important industrial community, lies 5½ miles to the west of the airport.

Because the county is large and most of its population is concentrated in its northern section, the zoning maps are in ten sections. Such a procedure was authorized in the enabling legislation. Each section corresponds, with one minor exception, to one of the various "Hundreds" into which the county is divided. These "Hundreds" are representative and census-enumeration districts but have no local government; their boundaries, in general, follow water courses, thus making them natural subdivisions for zoning purposes.

Hearings on the proposed zoning code were started in November, 1952, and nine hearings had been held prior to July, 1953, the last four of these hearings being devoted both to the code and to three of the sectional maps (including the New Castle County Airport and its principal approaches) which had been completed. At each of these hearings there was also presented a map entitled "Height Regulations on Approaches to New Castle County Airport." The essential features of this map are shown in Fig. 6. This map supplements, but does not legally form a part of, Article XVI of the code ("Special Regulations Around Airports"). It contains the following desirable features for airport zoning maps:

1. The airport reference point, given by latitude and longitude, rather than by state coordinates as recommended by Mr. Beavin.

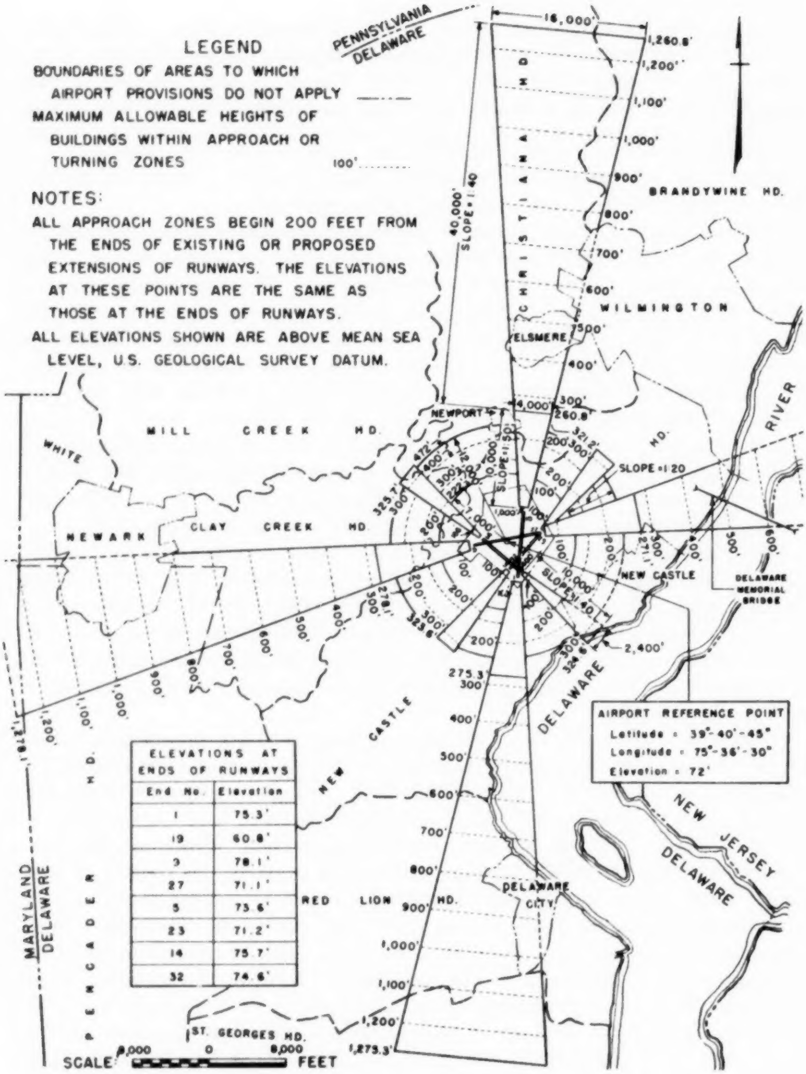

FIG. 6.—HEIGHT REGULATIONS ON THE APPROACHES TO THE NEW CASTLE COUNTY AIRPORT, NEW CASTLE COUNTY, DELAWARE

2. Horizontal limits of areas within which controls are established, fixed by radial distances from the airport references point and by wedge-shaped areas extending beyond each runway end.

3. The elevation of the airport reference point and of runway ends, referred to mean sea level.

4. The elevations above mean sea level of all points within the approach areas subject to height control, with the permitted elevations of new structures shown by 100-ft contours and 20-ft ground contours and the existing street system throughout the area of the map.

The writer believes that the combination of this map and the sections of the code relating to it provides a practical example of the application of zoning to the control of airport approaches.

The following airport zoning restrictions in the New Castle County code have met with such general endorsement that no changes have been made since the initial hearing.[3]

Article XVI—Special Regulations Around Airports

Section 1. Purpose.—In order to provide free air space for the safe descent, landing, and ascent of aircraft and to prevent undue hazard to the life or property of the occupants of buildings within airport approach or turning zones, the following special regulations in this Article shall apply apply to any land airport, other than a helicopter landing facility, owned and operated by a public agency or in instrumentality thereof and designated by Resolution of the Levy Court as a "major airport."

Section 2. Limitation of Height Within Approach Zones.—Within the air space above the approach zone to each end of each airport runway no building structure shall be erected or altered to project above the following planes:

(1) In the case of runway used or designed to be used for instrument landings, a plane with a slope of 1 (vertical) to 50 (horizontal) projected from a point two hundred (200) feet beyond the end of the existing runway or proposed extension thereof for a distance of ten thousand (10,000) feet, said plane to be in the shape of a symmetrical trapezoid one thousand (1,000) feet in width at its lowest point and four thousand (4,000) feet in width at its highest point; combined with a second plane with a slope of 1 (vertical) to 40 (horizontal) extending from the upper edge of the first plane for an additional distance from the airport runway of forty thousand (40,000) feet, said plane to be in the shape of a symmetrical trapezoid four thousand (4,000) feet in width at its lowest point and sixteen thousand (16,000) feet in width at its highest point.

(2) In the case of any other runways, a plane with a slope of 1 (vertical) to 40 (horizontal) projected from a point two hundred (200) feet beyond the end of the existing runway or proposed extension thereof for a distance of ten thousand (10,000) feet, said plane to be a symmetrical trapezoid four hundred (400) feet wide at its lowest point and two thousand four hundred (2,400) feet wide at its highest point.

Section 3. Limitation of Height Within Turning Zone.—Within twelve thousand (12,000) feet from the airport reference point as established by the Civil Aeronautics Administration, no building or structure shall be erected or altered to project within the air space of the airport turning zone defined as the space above the following surfaces:

(1) A horizontal surface one hundred and fifty (150) feet above the established airport elevation as determined by the Civil Aeronautics Administration and extending seven thousand (7,000) feet radially from the airport reference point as determined by the Civil Aeronautics Administration.

(2) A conical surface beginning at the outer edge of the horizontal surface as described in the above paragraph and extending outward with each element thereof rising on a slope of 1 (vertical) to 20 (horizontal) to a distance of twelve thousand (12,000) feet from the airport reference point as determined by the Civil Aeronautics Administration.

Section 4. Map showing Application of Provisions.—A map showing the approximate maximum heights to which any building or structure may be built within the area subject to the controls set forth above shall be on file in the office of the Building Inspector of New Castle County.

Section 5. Existing Obstructions.—Any present existing obstructions of record on the date of adoption of this Code shall be exempt therefrom, but nothing herein contained shall be interpreted to prevent negotiations, or the exercise of right of eminent domain by a public agency, for the removal of such present obstructions.

Section 6. Exception to Above Provisions.—In no case shall the provisions of this Code prevent the erection of a building or structure distant one hundred (100) feet or more from the boundary of an airport to a maximum height of twenty (20) feet above natural ground level.

The Zoning Commission of New Castle County plans to submit its final report on the entire code, together with maps for the five northern sections to the Levy Court (the county's legislative body) in the fall of 1953.

Two of the runways on New Castle County Airport are designed to be used for instrument landings and their approaches follow the pattern shown in Fig. 1. It is indicated in Fig. 1 that the controlled areas for their approaches extend to a distance of 50,000 ft from a point 200 ft beyond the ends of the runways, with a slope of 1 on 50 for the first 10,000 ft and a slope of 1 on 40 beyond. For the other two runways, controls extend to a distance of 10,000 ft from a point 200 ft beyond the end of the runways with a slope of 1 on 40. The approaches to the east-west instrument runway extend over a portion of New Jersey on the east and just over the Maryland-Delaware boundary line on the west. These areas outside New Castle County and the incorporated municipalities in the county are not subject to the zoning provisions, but it will be noted that the approach areas avoid all but a negligible corner of New Castle and all of Wilmington except some small residential sections on the extreme western edge. The town of Elsmere, Del., lies directly in the northern approach to an instrument runway, but at this location the approach surface is approximately 300 ft above the ground. Although the southern part of Newark is also within an instrument runway approach, the permissible height of a structure at that distance would be 800 ft above ground level, making the control nonrestrictive.

The edge of the conical-shaped section of the turning zone area, extending 12,000 ft from the airport reference point, extends over a part of New Castle and just reaches Newport, Del.

The only points at which the proposed controls would hit developed areas are at the southern end of the north-south instrument runway and near the eastern corner of the airport where an instrument and a noninstrument runway intersect.

Section 1 of that part of the code previously quoted aroused discussion at the public hearings, since the county also contains airports (owned by industrial companies) which are used primarily for experimental purposes. It should be noted that the code applies only to a

"***land airport, other than a helicopter land facility, owned and operated by a public agency or an instrumentality thereof and designated by the Resolution of the Levy Court as a 'major airport'."

It is expected that only the New Castle County Airport will be designated as a "major airport," but the code provisions would apply to any additional airport of similar character that might be constructed and so designated.

Section 5 (previously quoted) implies that, in some cases, additional control might be exercised through eminent domain. Mr. Beavin has stated that "***restricting the heights of the structures that may be built in residential areas to something less than that of a two-story house***may only be construed as a taking away of a considerable part of the value of the properties so restricted." In conformance with this theory, Section 6 provides that the code would not prevent the erection of a building to a height of 20 ft if located 100 ft or more from the boundary of the airport.

No attempt was made to incorporate in the code any control over the "transitional surfaces" shown in Figs. 4 and 5 and covered in the Technical Standard Order No. N18 of the CAA. No objection to this omission was made at the public hearings.

The writer feels that the descriptive presentation supplemented by a map (as developed for New Castle County) has advantages over such a tabular presentation as Mr. Beavin proposes. It is also easier for the layman to comprehend. The map shows at a glance all the areas where height controls will apply, and permits an owner or prospective builder to determine (from a simple scaling of the map and computations of differences between ground elevation and permissible structure elevation) the approximate height to which a structure can be erected at any specific location.

Benjamin Everett Beavin, Sr.,[4] M. ASCE.—The technique followed by

[4] Partner, Porter, Urquhart & Beavin, Newark, N. J., and Baltimore, Md.

Mr. Lewis in preparing a zoning code for New Castle County is commendable and should provide an instrument whereby the zoning commission can protect both the approaches to the airport and the interests of its neighbors.

Although in Fig. 6 it was not possible to show extensive detail, the positions of the runway ends (with relation to the airport reference point) and the azimuths of the approach zones were undoubtedly fixed in the zoning ordinance.

Because of the facility with which engineers and surveyors can settle possible conflicts between proposed construction and zoning restrictions, state plane coordinates are preferable to the geographic coordinates used by Mr. Lewis at New Castle County Airport. Given the geographic coordinates, however, the state coordinates can be computed readily. If the astronomic bearings of the approaches are given in the ordinance, a correction must be applied before computing the state coordinates of the runway ends and other points. It would seem better to fix all positions by plane coordinates in the ordinance, rather than to cause the same computations to be made several times during the life of the ordinance. It also may be desirable to have the geographic coordinates of the airport reference point given in zoning ordinances, in addition to the state plane coordinates.

The writer hopes that the paper and the discussion by Mr. Lewis will be of service to other members of the profession. It is also hoped that further efforts by the profession may lead to the correlation of zoning regulations among governmental agencies in the United States.

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a. Beginning with "Proceedings-Separate No. 200," published in July, 1953, the papers were printed by the photo-offset method.

b. Presented at the Miami Beach (Fla.) Convention of the Society in June, 1953.

c. Presented at the New York (N.Y.) Convention of the Society in October, 1953.

d. Beginning with "Proceedings-Separate No. 290," published in October, 1953, an automatic distribution of papers was inaugurated, as outlined in "Civil Engineering," June, 1953, page 66.

e. Discussions, grouped by divisions.